2017 Arboviral Disease Surveillance Annual Report

AD ASTRA PER ASPERA
Kansas
Department of Health and Environment

Contents

Background

Arboviruses (arthropod-borne virus) are commonly spread to humans through the bites of infected mosquitoes, ticks, sand flies, midges, and other invertebrate vectors. This report focuses on mosquito transmitted arboviruses. West Nile virus (WNV) is the leading cause of domestically acquired arboviral disease in the United States and Kansas[1]. WNV was first identified in the United States in 1999 and spread throughout the United States. Natural transmission involves a mosquito-bird-mosquito cycle; animals such as humans and horses do not circulate enough virus to re-infect a blood-feeding mosquito, and thus are referred to as "dead-end" or "accidental" hosts. Several species of mosquitoes are responsible for transmission of arboviruses but *Culex* species are the primary vector for WNV in the United States.

The incubation period for arboviral infections vary. The incubation period for WNV ranges from 3 to 15 days with an average incubation period of approximately one week. Arboviral infections may be asymptomatic or may result in illness of variable severity. Approximately 80% of people who become infected with WNV do not develop any symptoms[1]. About one in five people who are infected develop a fever with other symptoms such as headache, body aches, joint pains, vomiting, diarrhea, or rash[1]. Most people with 'West Nile virus Fever' recover completely but fatigue and weakness can last for weeks or months[1]. Less than 1% of people who are infected develop a serious neurological illness, such as encephalitis or meningitis, and approximately 10% of people who develop this kind of an infection will die[1].

From 1999 – 2017 there were a total of 48,183 cases and 2,163 deaths in the United States from WNV with 617 cases and 30 deaths that occurred in Kansas[2]. Kansas has among the highest incidence of WNV neuroinvasive disease in the country where Kansas almost always exceeds the national incidence[3]. In 2016, the incidence of WNV neuroinvasive disease was 0.58 cases per 100,000 people compared to 0.41 cases per 100,000 people for the U.S[2].

The Kansas Department of Health and Environment (KDHE) began surveillance for WNV in 2001 with a grant from the Centers for Disease Control and Prevention (CDC). The first WNV positive mosquito specimens were collected on July 23, 2002; the first equine case and human case had onset of WNV on August 6 and August 8, 2002 respectively[4]. Although this mosquito surveillance system is focused on WNV it is important to note that all arboviral diseases, when diagnosed in humans, are required to be reported to KDHE by laboratories and healthcare providers among others.

A cooperative agreement through the CDC to KDHE funds mosquito surveillance in Kansas. Our surveillance program in Kansas has evolved since it was first implemented by KDHE in 2001. In the beginning the goal of mosquito surveillance was to determine when and where WNV arrived in Kansas. After WNV became established in our state in 2002 the goal shifted to develop an early warning system to determine when people would be most at risk for acquiring the disease. A systematic surveillance system evaluation of data from 2002 – 2009 found WNV was detected in mosquitoes weeks after transmission to humans had occurred [5]. This surveillance method was not useful to determine potential risk of WNV transmission to people. In 2010, mosquito surveillance was not conducted as we evaluated potential methods to improve mosquito surveillance for WNV in Kansas. In 2011 mosquito surveillance was performed in response to floods in Atchison and Doniphan counties in northeast Kansas.

In 2012, mosquito surveillance was conducted in nine counties; one Encephalitis Vector Survey (EVS) trap per county per week from mid-May – mid-October. From 2013 – 2016, mosquito surveillance was conducted solely in Sedgwick County where WNV neuroinvasive disease cases had historically been reported most frequently in Kansas. In 2017, KDHE received additional funding for mosquito surveillance from CDC as part of the Zika virus response. We were able to add two additional counties, Reno and Shawnee, to the mosquito surveillance network. In 2017, Johnson County funded mosquito surveillance in their communities and KDHE tested their mosquitoes for WNV.

In 2017, KDHE developed West Nile virus 'Risk Levels'. The goal of these risk levels was to translate the mosquito surveillance data into discrete measures of risk of acquiring a WNV infection. Elements of existing WNV risk models from other states were used to develop a Kansas model based on available resources.

Methods

Mosquito Surveillance

Mosquito Collection

Mosquito surveillance for WNV was conducted from May 24 to October 25, 2017 by Dr. D. Christopher Rogers with the Kansas Biological Survey (KBS). Surveillance was conducted weekly in Reno, Sedgwick, and Shawnee counties. Surveillance was conducted every other week in Johnson County. The traps were placed where the highest densities of potential mosquito oviposition and resting habitat was found, potential bird/mosquito movement corridors, bird nesting habitats (riparian corridors), and in conjunction with large human populations.

EVS traps, with dry ice as a carbon dioxide source, was primarily used to collect mosquitoes. These traps typically attract mosquitoes that feed on humans or other mammals; our primary mosquito genus of interest was *Culex*. Nine traps were set each week in Sedgwick County and five traps were set in Reno and Shawnee counties weekly, always at the same monitoring sites. The traps were placed at their designated locations in the early evening and were collected the following morning. The trap contents were secured in a container and labeled with the address and GPS coordinates of the trap location. The mosquitoes were then transported on dry ice to KBS at the University of Kansas for identification.

BG-Sentinel traps, with BG-Lure as an attractant, was used to survey for *Aedes aegypti* and *Aedes albopictus* mosquitoes. One BG-Sentinel trap was set each week in Reno, Sedgwick, and Shawnee counties.

Mosquito Identification

The KDHE contracted with KBS to enumerate and identify mosquitoes to the species level. Upon arrival, all mosquito samples were checked in, and stored in a -80°C ultracold freezer. All mosquitoes were identified on a chill table under a Wild M-8 stereo dissection microscope, using the appropriate standard references and the KBS voucher reference collections. Mosquito counts greater than 1,000 per trap were divided into a smaller subset for identification due to budget constraints (proportional extrapolation identifications). All mosquito taxa were recorded and enumerated. Mosquitoes of the genus *Culex (Culex spp.)*, the most common WNV vector, were separated out, labeled according to location and date collected, and returned to the -80°C ultracold freezer. Once all collections were identified, the *Culex* spp. subsets were hand transported in an ice chest with dry ice to the University of Kansas Blumenstiel lab for arboviral testing. Results from the enumeration and identification were entered in a Microsoft® Excel® spreadsheet and submitted by KBS to KDHE weekly via e-mail. Mosquito data was presented for each trap as total numbers, total taxa, total source (e.g.: tree hole/container species, floodwater species, et cetera) use numbers, total *Culex* spp., total *Aedes aegypti/ albopictus* numbers, coupled with the same data for previous years for direct comparison, and concurrent temperature and precipitation data.

West Nile Virus Testing of Mosquitoes

Culex spp. were tested for WNV at the Blumenstiel lab at the University of Kansas. Mosquitoes were divided into homogenizer vials by date and trap location containing up to 75 mosquitoes each and tested for WNV by reverse transcription polymerase chain reaction (RT-PCR). The results were entered in an Excel® spreadsheet and sent to KDHE. All results were posted to KDHE's website and reported to the ArboNET a national arboviral surveillance system managed by CDC and state health departments.

Human Case Surveillance

West Nile virus, and all other arboviral diseases, are reportable diseases in Kansas. It is a passive surveillance system; healthcare providers or laboratories are required to report cases to KDHE. Cases were classified according to the most recent CDC case definition (Appendix A). Confirmed and probable cases are reported to CDC and are included as the case count (e.g. confirmed + probable = total number of cases). It is important to note that these definitions are to be used for case counts only and should not be used to make a clinical diagnosis. In addition, the county in which the person resides is used as the case's location for surveillance purposes, although they may have been infected elsewhere. Prior to 2011, Kansas only reported confirmed cases, therefore, we are only able to compare case counts and rates of WNV from 2011 to present.

The cases were entered into EpiTrax, Kansas' electronic disease surveillance system, and the corresponding local health department completed the investigation. The Arboviral Disease Investigation Guidelines contains information to provide technical assistance with local surveillance and disease investigation. They contain disease-specific information, sample letters, reporting forms, sample communication sheets, and other tools to assist the local health department. Once the case investigation is complete, all confirmed and probable cases are reported to the ArboNET surveillance system and the results are posted to the ArboNET website. Information on human WNV case counts and rates can be found in KDHE's annual publication, Reportable Infectious Diseases in Kansas.

The incidence rate (number of cases per 100,000 people) of WNV neuroinvasive disease cases for Reno, Shawnee, and Sedgwick County was compared to the State of Kansas, the West North Central region (Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and South Dakota), and the United States. Incidence rates were limited to neuroinvasive disease cases as reporting for these cases is believed to be more consistent and complete than for non-neuroinvasive disease cases[6].

Animal Case Surveillance

West Nile virus infections in horses are required to be reported to the Kansas Department of Agriculture's Division of Animal Health. Horses may serve as a sentinel of WNV activity in Kansas. Kansas does not conduct surveillance of dead birds for WNV. However, the Kansas Department of Wildlife, Parks, and Tourism shares WNV positive laboratory results, when diagnosed in wildlife, as a courtesy with KDHE.

Mosquito Control

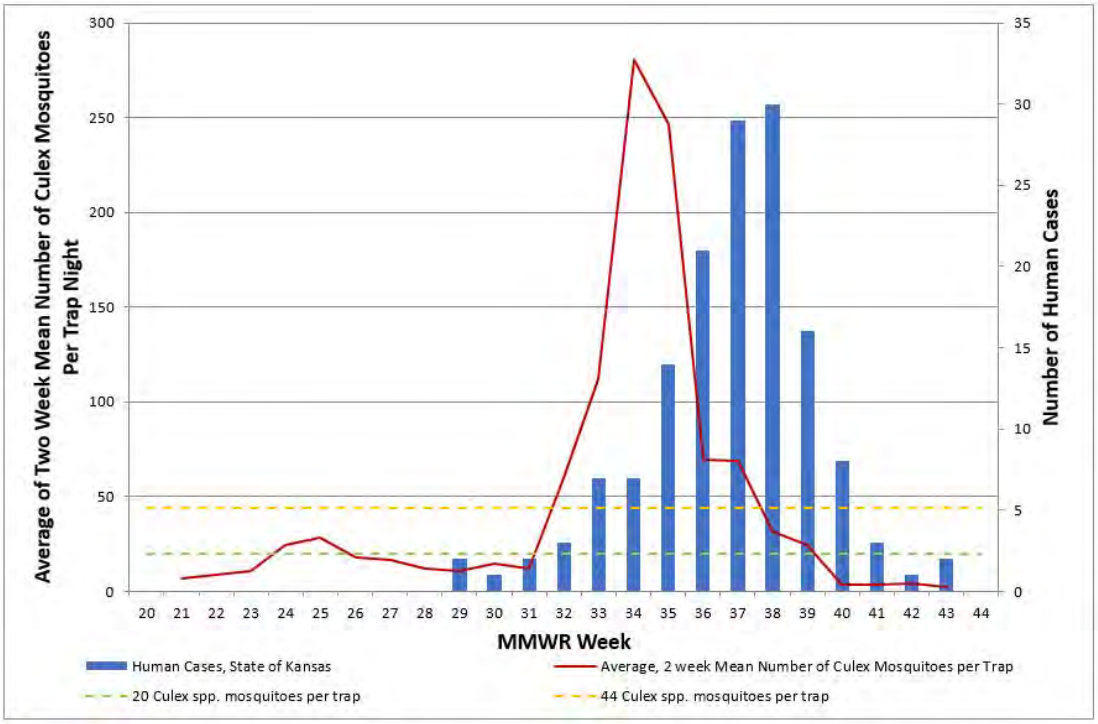
The State of Kansas does not maintain a vector control program. Mosquito control, if performed, is conducted by city or county governments. A 2015 survey found that none of the cities or counties that performed mosquito control (apart from the City of Wichita) used mosquito surveillance to guide their abatement decisions[7]. The Reno, Sedgwick, and Shawnee County Health Departments shared mosquito surveillance data weekly with the municipalities where the traps were located and provided control recommendations as needed.

West Nile Virus Risk Levels

In 2017, KDHE developed a system to quantify risk, based on other state models and available data, in Kansas. Mosquito surveillance was conducted weekly with 23 EVS traps in 4/105 counties (Johnson, Reno, Sedgwick, and Shawnee) from May 24-October 25, 2017. Three regions were created; west, central, and east. Sedgwick and Reno county data were combined for west and central region risk levels and Shawnee and Johnson county data were combined for the eastern region.

Evaluation of surveillance data from 2013 and 2014 revealed a strong correlation between the two-week mean *Culex spp.* prevalence and human cases that occurred in Sedgwick County, and the entire state of Kansas, two and three weeks later[3]. The majority of cases occurred in Sedgwick County, and the entire state, two weeks after the two-week mean *Culex spp.* prevalence was $\geq$44 *Culex* mosquitoes per trap night[3] (Figure 1).Therefore, threshold measures for risk levels were developed based on presence of *Culex spp.* mosquitoes (low risk), two-week mean *Culex spp.* mosquitoes $\geq$40 per county (moderate risk), and either human case counts that exceeded the WNV five year (2012-2016) median (east and central regions) or mean (west region) case counts or WNV positive mosquito pools (high risk). Risk levels of minimal, low, moderate, and high had coordinating prevention measures. Risk levels were updated weekly from June 16-November 3, 2017 and posted on the KDHE Arboviral Disease webpage.

Figure 1. Two-Week Mean Culex Mosquito Prevalence and Human Cases Two Weeks Later, Kansas, 2013-2014.



Results

Mosquito Surveillance

Mosquito Identification

Mosquito collection began on May 24, 2017 and continued weekly through October 25, 2017 for a total of 23 surveillance weeks. A mosquito species not previously identified in Kansas, *Ochlerotatus japonicus,* was found in Shawnee County the last week of June. All other mosquito species had been previously identified in Kansas.

Mosquito Abundance

There were 20,141 mosquitoes collected during 483 trap nights (Johnson County = 44, Reno County = 138, Shawnee County = 138, Sedgwick County = 207) in 2017. A trap night is calculated as the number of traps per night multiplied by the number of nights of surveillance. There were four traps run once every two weeks in Johnson County, six traps run once per week in Reno and Shawnee County, and nine traps run once per week in Sedgwick County.

Mosquito surveillance was last performed in Johnson County in 2016. There were 3,057 mosquitoes collected in Johnson County in 40 trap nights in 2017 (Table 1).

Table 1. Mosquito species collected by year, Johnson County*.

Mosquito Species	**2016†** **# (*%*)**	**2017** **# (*%*)**
Total mosquitoes	1,297	3,057
Total Culex spp.	185 (***14***)	308 (***10***)
Aedes vexans	379 (***29***)	658 (***22***)
Culex tarsalis	29 (***2***)	4 (***0.1***)
Culex pipiens/quinquefasciatus	60 (***5***)	16 (***0.5***)
Culex erraticus	63 (***5***)	205 (***7***)

**The percent (%) of mosquito species was calculated by dividing the number (#) of that species by the total number of mosquitoes collected during the 2017 season from 4 traps. †There were 40 traps nights in Johnson County in 2016.*

Mosquito surveillance was last performed in Reno County in 2003 using a different method, therefore, we did not compare 2017 data to previous years for that county. There were 3,623 mosquitoes total collected in Reno County with just over half of them *Culex spp.* The majority of the *Culex spp.* were *Culex tarsalis* (42%) (Table 2).

Table 2. Mosquito species collected by year, Reno County*.

Mosquito Species	**2017** **# (*%*)**
Total mosquitoes	3,623
Total Culex spp.	1863 (***51***)
Aedes vexans	775 (***21***)
Culex tarsalis	1,533 (***42***)
Culex pipiens/quinquefasciatus	64 (***2***)

**The percent (%) of mosquito species was calculated by dividing the number (#) of that species by the total number of mosquitoes collected during 2017 season from 6 traps. Mosquito surveillance was last conducted in Reno County in 2003.*

Overall there was a significant decrease in the number of total mosquitoes and *Culex spp.* mosquitoes in Sedgwick County when compared to 2016 (Table 3). There was also the fewest number of total mosquitoes and *Culex spp*. captured since the beginning of intensive surveillance in Sedgwick County in 2013. The proportion of total *Culex spp.* was higher in 2017 than the previous three years (2014 – 2016) however it was significantly lower when compared to 2013.

Table 3. Mosquito species collected by year, Sedgwick County*.

Mosquito Species	2013 # (%)	2014 # (%)	2015 # (%)	2016 # (%)	2017 # (%)
Total mosquitoes	24,074	17,700	39,624	21,790	4,322
Total Culex spp.	16,819 (***70***)	2,137 (***12***)	8,103 (***20***)	3,253 (***15***)	1,299 (***30***)
Aedes vexans	6,683 (***25***)	11,728 (***68***)	25,736 (***65***)	10,987 (***50***)	1,750 (***41***)
Culex tarsalis	9,485 (***35***)	1,425 (***8***)	6,698 (***17***)	1,979 (***9***)	593 (***14***)
Culex pipiens/quinquefasciatus	6,683 (***27***)	892 (***5***)	1,307 (***3***)	890 (***4***)	77 (***2***)

**The percent (%) of mosquito species was calculated by dividing the number (#) of that species by the total number of mosquitoes collected during the 2017 season from 9 traps.*

Mosquito surveillance was last performed in Shawnee County in 2009 using a different method, therefore, we did not compare 2017 data to previous years. There were 9,139 total mosquitoes collected in Shawnee County with nearly seventy percent *Culex spp.* (Table 4). However, the majority of the *Culex spp.* in Shawnee County were *Culex erraticus (66%)* with very few *Culex tarsalis* (0.7%).

Table 4. Mosquito species collected by year, Shawnee County*.

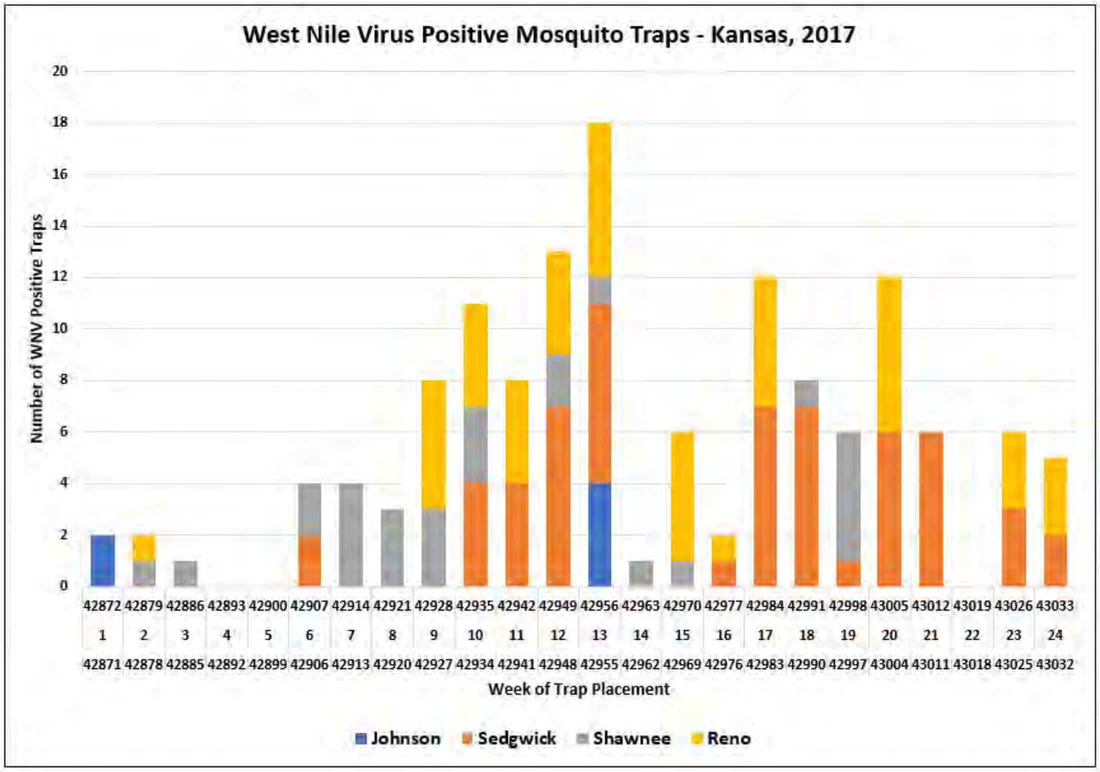
Mosquito Species	2017 # (%)
Total mosquitoes	9,139
Total Culex spp.	6,333 (***69***)
Aedes vexans	907 (***10***)
Culex tarsalis	65 (***0.7***)
Culex pipiens/quinquefasciatus	38 (***0.4***)
Culex erraticus	6,010 (***66***)

**The percent (%) of mosquito species was calculated by dividing the (#) of that species by the total number of mosquitoes collected during the 2017 season from 6 traps. Mosquito surveillance was last conducted in Shawnee County in 2009.*

West Nile Virus Testing

2017 had the greatest number and highest proportion of traps with WNV positive mosquitoes. Of the 527 traps tested 26.2% (n = 138) were positive for WNV. Typically, Kansas only has 1-2 traps, <2% tested, with WNV positive mosquitoes per season. The first WNV positive mosquitoes were collected in Johnson County on 17 May (Figure 2). This is the earliest we have confirmed WNV in mosquitoes in Kansas since we began our new surveillance methods in 2012. From 2013 – 2016 the first WNV positive mosquitoes were collected in mid-August. There were WNV positive mosquitoes identified weekly from mid-June – early October in 2017 (Figure 2).

Figure 2.



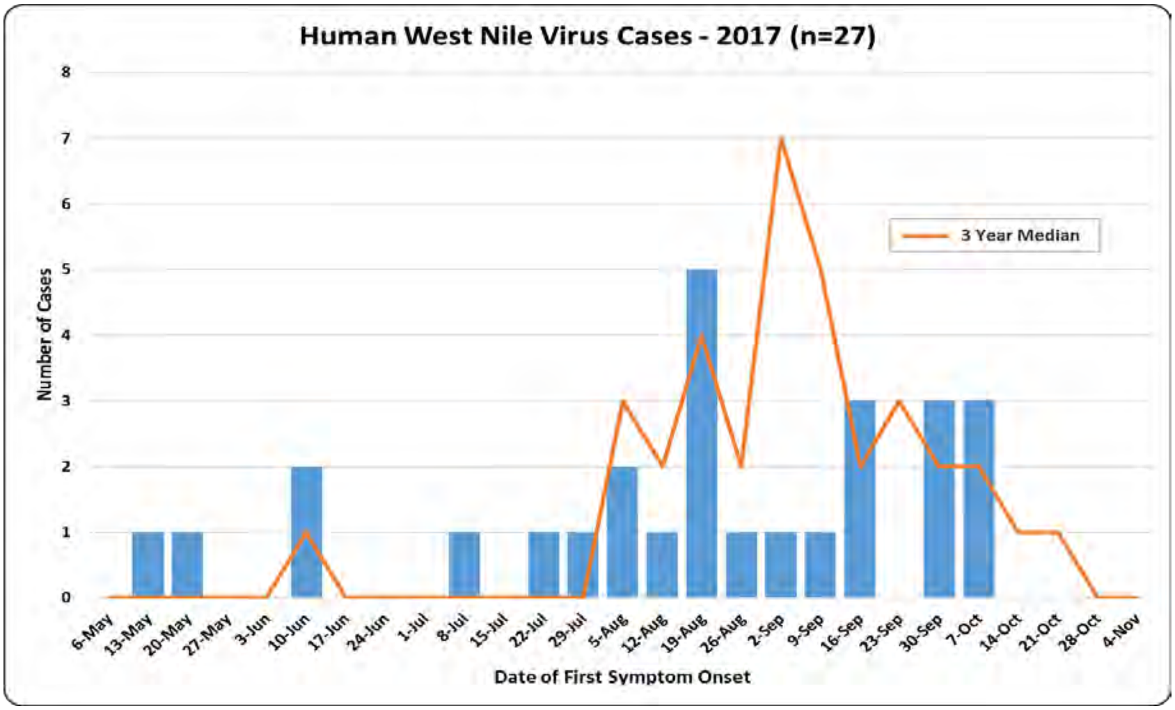
Human Case Surveillance

Twenty-seven human WNV cases were reported in the State of Kansas in 2017 (Table 5). This was a decrease of 10 cases from 2016 (N = 37). There were 15 cases of non-neuroinvasive WNV and 12 cases of neuroinvasive WNV. There was a 29% decrease in the number of neuroinvasive disease cases compared to 2016 (Table 5). The earliest had onset of illness in May; the majority (63%) of cases had disease onset beginning in August or September (Figure 3). In the previous four years the majority (83%, four-year median) of cases had onset of disease in August and September. In 2017 seven percent of cases had disease onset in May; this was the earliest reported cases since 2012 which had one case with a disease onset in April. The median age of case-patients was 54 years (range 5 – 89 years) and most were male. Twenty cases (74%) were hospitalized. No deaths caused by WNV were reported in 2017.

Table 5. Human West Nile virus case characteristics, Kansas, 2013-2017.

	2013	2014	2015	2016	2017
Number of Cases	**92**	**54**	**34**	**37**	**27**
Age (years)					
Median	59.5	54	60	59	54
Range	12-85	10-78	26-82	26-88	5-89
			Number of Cases (%)		
Gender					
Male	63 (68)	32 (61)	21 (62)	28 (76)	22 (81)
Female	29 (32)	20 (39)	13 (38)	9 (24)	5 (19)
Month of Disease Onset					
May	0	0	0	0	2 (7)
June	0	0	2 (6)	3 (8)	2 (7)
July	3 (3)	1 (2)	3 (9)	7 (19)	3 (11)
August	13 (14)	23 (43)	12 (35)	13 (35)	9 (33)
September	67 (73)	27 (50)	15 (44)	9 (24)	8 (30)
October	9 (10)	3 (6)	2 (6)	5 (14)	3 (11)
Clinical Status					
Neuroinvasive disease	33 (36)	18 (33)	12 (35)	17 (46)	12 (44)
Non-neuroinvasive disease	59 (64)	38 (70)	22 (65)	20 (54)	15 (56)
Hospitalized	56 (61)	27 (52)	20 (59)	25 (68)	20 (74)
Died	8 (9)	0	2 (6)	5 (14)	0

Figure 3.



Peak cases occurred approximately two weeks earlier, mid-August, then in previous years (Figure 3). This pattern occurred in Kansas and throughout the United States[2].

West Nile virus Neuroinvasive Disease

From 2016 to 2017 the neuroinvasive incidence rate decreased in Reno County (zero cases), Sedgwick County (0.20 per 100,000), the State of Kansas (0.41 per 100,000), and the West North Central region (Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and South Dakota) (0.56 cases per 100,000). The incidence rate of WNV for Kansas was lower than the incidence rate for the United States (0.44 per 100,000) in 2017 (Table 6).

There were two cases of neuroinvasive WNV disease in Shawnee County in 2017 compared to one case in 2016 (Table 6). The three-year median (2014-2016) for neuroinvasive disease in Shawnee County was zero cases. The remaining two WNV neuroinvasive disease cases in Shawnee County had onset of disease within three weeks of each other in late August and mid-September.

Table 6. West Nile virus neuroinvasive disease count and incidence rate* by year, 2012-2017.

Region	**2013**		**2014**		**2015**		**2016**		**2017**	
	Count	*Rate*	*Count*	*Rate*	*Count*	*Rate*	*Count*	*Rate*	*Count*	*Rate*
Sedgwick County	4	0.79	0	-	2	0.39	4	0.78	1	0.20
Shawnee County	0	-	0	-	0	-	1	0.56	2	1.12
Reno County	4	6.28	0	-	0	-	2	3.14	0	-
Kansas	34	1.17	18	0.62	12	0.41	17	0.58	12	0.41
West North Central†	288	1.38	104	0.50	82	0.39	175	0.82	118‡	0.56
United States	1,267	0.40	1,347	0.42	1,455	0.47	1,310	0.40	1,425‡	0.44

**Number of cases per 100,000 population, based on U.S. Census population estimates for July 1, 2017.*
† West North Central region; Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and South Dakota.
‡ Data from https://www.cdc.gov/westnile/statsmaps/preliminarymapsdata/histatedate.html. Accessed Oct. 4, 2018.

Other Arboviral Diseases

In 2017, there were six cases of other arboviral diseases reported to KDHE. There was a significant decrease in the number of Zika cases from 2016 (n = 20) to 2017 (n = 3). Dengue virus infections decreased from four cases in 2016 to two in 2017.

All people reported with Chikungunya virus (n = 1), dengue virus (n = 2), and Zika virus (n = 3) acquired the disease outside of the United States in countries where these diseases were endemic. All three Zika virus cases reported travel to countries in the Caribbean or Central America.

Animal Case Surveillance

There was one WNV-positive animal reported to KDHE in 2017 (Table 7).

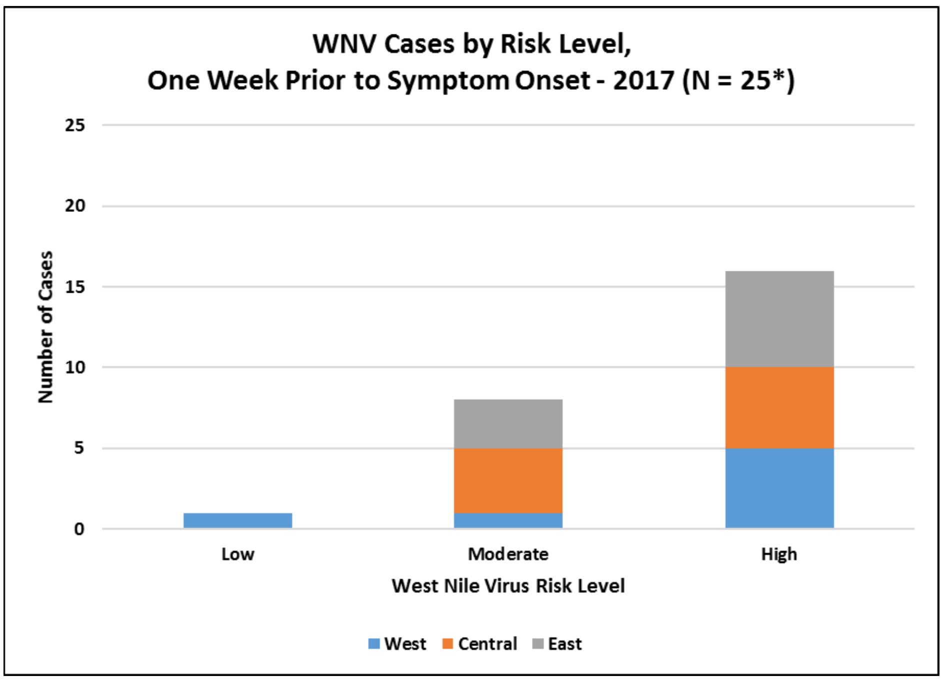
Table 7. Animal cases of West Nile virus – Kansas, 2017.

Date of Specimen Collection	**County**	**Animal**
July 27	Reno	Horse

West Nile Virus Risk Levels

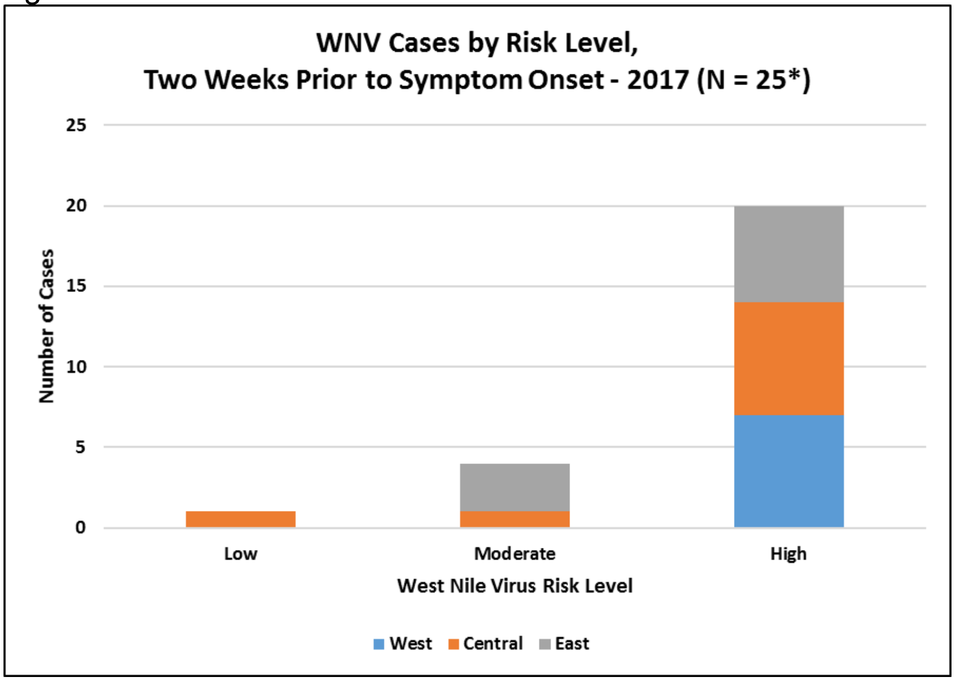
The first WNV risk level was published on June 16, 2017. They were published weekly for 21 weeks. We calculated risk levels for all 24 weeks of surveillance for analysis. In each region, fifteen weeks (60%) were at high risk. In the west and central regions there were four weeks at moderate and five weeks at low risk levels. In the east region there were seven weeks at moderate and two weeks at low risk levels. The number of WNV cases throughout the state were compared to the corresponding risk level one and two weeks prior to the onset of disease symptoms. Two of the 27 WNV cases were likely infected prior to the beginning of mosquito surveillance and were excluded from this analysis. Sixty-four percent (16/25) of WNV cases occurred one week after a high risk level and 80% of WNV cases occurred two weeks after a high risk level (Figures 4,5).

Figure 4.



Two cases occurred prior to mosquito surveillance and were excluded from the analysis.

Figure 5.



**Two cases occurred prior to mosquito surveillance and were excluded from the analysis.*

Discussion

2017 was the first year that KDHE defined and implemented West Nile virus risk levels since mosquito surveillance began in 2001. The threshold for the risk levels was based on available mosquito surveillance data and historical human WNV case epidemiology. There are other states that utilize WNV risk models. KDHE reviewed several states WNV websites, and the peer-reviewed literature, to determine which variables would provide the best fit with Kansas' available surveillance data. One common thread among many of the risk models was the use of mosquito infection data. Historically, Kansas has had very few WNV-positive mosquitos collected from traps and therefore had been unable to use mosquito infection data for risk level modeling. WNV-positive mosquitoes were usually collected during peak human transmission and were not useful as a predictor of WNV activity or severity. In addition, significant delays in lab results prevented this data from being useful in prediction modeling. This was the first year the mosquito test results were received within the same week as mosquito collection. Mosquito lab testing capabilities will continue to be evaluated to determine if mosquito infection data can be used in future models.

The Saskatchewan Ministry of Health publishes a weekly West Nile virus surveillance report from June through September each year. Risk levels were calculated with *Cx. tarsalis* abundance, mosquito infection rates, heat accumulation, and other relevant factors[8]. The province was divided into four ecological zones from south to north. The primary vector for WNV in Canadian prairies, as in Kansas, is *Cx. tarsalis*[9]*. Culex tarsalis* was more abundant in the southern grassland ecoregions[9]. Kansas has eleven physiographic regions and eight types of vegetation cover[10]. The predominant physiographic regions, from west to east, include the high plains, Smoky Hills, and Osage Cuestas. The predominant vegetative cover, from west to east, include shortgrass prairie, mixed prairie, and tallgrass prairie. Our state was divided into three regions for the first year of Kansas' WNV risk levels primarily for ease of use. Our regions will be refined in the future and to include temperature to improve WNV risk level predictions.

The Massachusetts Department of Public Health published an Arbovirus Daily Update with risk categories for both WNV and Eastern Equine virus encephalitis. There are four categories; low, moderate, high, and critical. All four levels have corresponding prevention measures. The prevention measures are easy to understand and increase with risk[11]. Kansas' risk prevention steps were based on the Massachusetts model.

In the fall of 2016, there were two reports of fatal cases of neuroinvasive WNV cases in Turon, Kansas. Turon, population 378, spans three counties (Pratt, Reno, and Stafford) in southcentral Kansas just west of Sedgwick County. Mosquito surveillance had last been conducted in Reno County in 2003, Stafford County in 2005, and Pratt County in 2009. Surveillance was discontinued due to decreased funding for this program. Fortunately, additional funds were received for mosquito surveillance from CDC for 2017 and two counties (Reno and Shawnee) were added to Kansas' program. Two EVS traps were placed near Turon on May 10, 2017. The next morning there were an estimated 600 female Culex mosquitoes in each trap. KDHE, KBS, and the Reno County Health Department held a conference call with entomologists from the CDC. They recommended spraying with adulticide twice a week based on the adult mosquito counts. A monumental community outreach effort was conducted. Turon city officials went door-to-door to distribute educational materials and larvicidal dunks to residents. Educational material was distributed through multiple media outlets including local papers, TV channels, social media, radio, and the Reno County Health Department website. Dr. Rogers, with the Kansas Biological Institute, conducted additional mosquito surveillance in and around Turon from May 30 – June 6. Significant sources of larval *Culex spp*. mosquitoes were found within, south and north of the city of Turon. Weekly adult mosquito surveillance continued until mid-October. These surveillance results were shared with Reno County Health Department and the City of Turon officials and were used to guide adulticide and outreach efforts. No cases of WNV were reported from Turon in 2017. Mosquito surveillance in Turon and Reno County will continue in 2018.

Kansans were encouraged to 'know your risk' to prevent West Nile virus. KDHE published the first WNV press release of the year on June 10, 2016 and June 9, 2017 respectively. Arboviral webpage views increased 471% when June 2016 (n=134) and June 2017 (n=2,188) were compared. Views from June-November increased 107% from 2016 (n=2,245) to 2017 (n=4,645).

Outbreaks of arboviruses, such as WNV, are difficult to predict due to the variety of factors that can influence transmission of this disease including weather (e.g. precipitation and temperature, animal and human host abundance), and human behaviors (e.g. use of repellent, outdoor activity, etc.)[6]. For the 2018 mosquito surveillance season, WNV risk levels will be enhanced through the addition of temperature data and refinement of the regions.

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Appendix A: West Nile virus surveillance case definition, 2017

Clinical Criteria for Surveillance Purposes

Neuroinvasive disease

- Fever (≥100.4°F or 38°C) as reported by the patient or a health-care provider, ***AND***
- Meningitis, encephalitis, acute flaccid paralysis, or other acute signs of central or peripheral neurologic dysfunction, as documented by a physician, ***AND***
- Absence of a more likely clinical explanation.

Non-neuroinvasive disease

- Fever (≥100.4°F or 38°C) as reported by the patient or a health-care provider, ***AND***
- Absence of neuroinvasive disease, ***AND***
- Absence of a more likely clinical explanation.

Laboratory Criteria for Surveillance Purposes

- Isolation of virus from, or demonstration of specific viral antigen or nucleic acid in, tissue, blood, CSF, or other body fluid, ***OR***
- Four-fold or greater change in virus-specific quantitative antibody titers in paired sera, ***OR***
- Virus-specific IgM antibodies in serum with confirmatory virus-specific neutralizing antibodies in the same or a later specimen, ***OR***
- Virus-specific IgM antibodies in CSF and a negative result for other IgM antibodies in CSF for arboviruses endemic to the region where exposure occurred, ***OR***
- Virus-specific IgM antibodies in CSF or serum.

Surveillance Case Definitions

Confirmed*:*

Neuroinvasive disease

A case that meets the above clinical criteria for neuroinvasive disease and one or more the following laboratory criteria for a confirmed case:

- Isolation of virus from, or demonstration of specific viral antigen or nucleic acid in, tissue, blood, CSF, or other body fluid, ***OR***
- Four-fold or greater change in virus-specific quantitative antibody titers in paired sera, ***OR***
- Virus-specific IgM antibodies in serum with confirmatory virus-specific neutralizing antibodies in the same or a later specimen, ***OR***
- Virus-specific IgM antibodies in CSF and a negative result for other IgM antibodies in CSF for arboviruses endemic to the region where exposure occurred.

Non-neuroinvasive disease

A case that meets the above clinical criteria for non-neuroinvasive disease and one or more of the following laboratory criteria for a confirmed case:

- Isolation of virus from, or demonstration of specific viral antigen or nucleic acid in, tissue, blood, CSF, or other body fluid, ***OR***
- Four-fold or greater change in virus-specific quantitative antibody titers in paired sera, ***OR***
- Virus-specific IgM antibodies in serum with confirmatory virus-specific neutralizing antibodies in the same or a later specimen, ***OR***
- Virus-specific IgM antibodies in CSF and a negative result for other IgM antibodies in CSF for arboviruses endemic to the region where exposure occurred.

Probable:

Neuroinvasive disease

A case that meets the above clinical criteria for neuroinvasive disease and the following laboratory criteria:

- Virus-specific IgM antibodies in CSF or serum but with no other testing.

Non-neuroinvasive disease

A case that meets the above clinical criteria for non-neuroinvasive disease and the laboratory criteria for a probable case:

- Virus-specific IgM antibodies in CSF or serum but with no other testing.

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To protect and improve the health and environment of all Kansans